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ABSTRACT

This collection of symposium papers provides current synthesis of research in the field of physical education and health. The importance of movement, body coordination, and physical activity in promoting better understanding and relationships between different ethnic groups is discussed. The hopeful possibilities provided by motor activities for trainable mentally handicapped children and Downs Syndrome children are also examined. (JD)

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SYMPOSIUM PAPERS:

ED166180

MOVEMENT STUDIES

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A NOTE TO THE READER

The Symposium Papers (Volume I, Books 1, 2, and 3) are published with one major purpose in mind. The papers are intended to provide the reader with an up-to-date synthesis of research in a wide variety of areas. Presentations were invited from each of the seven associations of AAHPER. Review boards screened Symposium Presentations under the direction of the Research Consortium President-elect. Special attention was given to the quality of the presentations and to the relevance of the research syntheses to the practioners in each of the seven associations.

The Symposium Papers are being made available for sale, for the first time, at the convention at which the actual papers are presented. This is done to make these research syntheses available to Alliance members at the earliest possible time, while the information is current and useful. To do this, it was necessary to make each author responsible for preparing his or her own manuscript. To be eligible for publication authors were required to submit their intent to publish early in the year and submit a manuscript, typed in the proper format, by March 1, 1978. In cases where authors failed to meet the above listed guidelines, the papers were deleted from this publication.

These Symposium Papers are photographed from original manuscripts submitted by each author. The screening of symposia served as the editing process, once accepted sole responsibility for the content rests with the author(s).

Because the Symposium Papers presented at the 1977 convention were not published, authors of these papers were invited to submit them for publication in this 1978 volume. Accordingly, Volume I includes some papers from 1977 as well as those from 1978.

It is hoped that these Symposium Papers are useful to members of all associations of AAHPER.

Charles B. Corbin
Editor

Christine L. Wells
President-elect
Research Consortium

Note: Because of the length limitation imposed on authors, reference lists are necessarily short. In most cases, more complete reference lists are available from authors on request.

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Bringing Ethnic Groups Together Through Movement: The Other Side of the Boston Story

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It is nonsense to bring children of different religions and ethnic backgrounds together in the schools through enforced integration in the hope that they will reduce social distance, without dramatically reviewing standing curricula, existing physical plant, and current attitudinal readiness.

In late 1974, when bussing in Boston became tangible and legal, educators geared up to meet problems which they knew would inevitably lead to organized opposition and occasional violence. Members of the Department of Movement, Health and Leisure at Boston University quickly involved themselves in grant writing, program planning, and staff training. Our first encounter set a pattern for many interesting, often frustrating, experiences thereafter. The Secretary of the local Bureau of Equal Educational Opportunity wrote us a letter informing us that a sizable grant had been awarded. We were elated: immediately began implementing the planned program: hired initial staff members, and geared up for what we knew would be an enormous challenge. We planned to bring urban and suburban children together for a program of physical activity at a neutral site. The key organizing center for reducing social distance, improving inter-ethnic attitudes, and safe-guarding the development of self concept was play.

We envisaged a divergent model beginning with proven sources of integration potential, like baseball, basketball, touch football, and soccer, developing through lesser available activities like wrestling, badminton, volleyball, skating, handball, and fencing, and climaxing through lifetime movement activities like hiking, climbing, orienteering and camping. We knew this program would work. Two weeks later we learned that the Secretary had skipped town, that there was no $80,000 in the kitty as we had been promised, and that his promise to us had for substance the whimsical caprice of kindly hot air.

This story typifies the frustration with which most educators have been confronted during the bussing in Boston episode. The original desegregation plan permitted too many loopholes. Fortunately, the current plan, which features alternatives in the form of magnet schools and school district pairing with the institutions of higher learning in and around Boston, along with strong levels of funding and resolution from the intellectual community, is much stronger.

Our experiences began in 1972, long before desegregation, when we invited 500 children from the urban areas to attend a laboratory physical education program carried out in our facility, and designed to provide a twofold focus of research and professional preparation. The Garrity ruling encouraged us to expand in the following ways:

1. Greater emphasis was placed on equating the numbers of each of the groups by sex and race.

2. A residential field experience, in a non-threatening environment well away from Boston, was introduced.
3. Research on social distance, self-concept, and interpersonal attitudes was intensified.

The new program, which is now in its third year, consists of three major components:

1. Activities at Boston University in what has been called our "laboratory school."
2. Activities in two pilot schools which are called our "field clinic laboratories."
3. Activities in residence 150 miles north of Boston called our "residential field laboratory."

Research during the project has centered around basic skills, attitudes, self-concept, social distance, and interaction patterns. Tom Martinek will report on self-concept and motor skills; Barbara Riley on social distance; and I will report on attitudes and interaction patterns.

Program development has centered around game skills, individual competitive and cooperative activities, and social activities involving the risk of interpersonal interaction. Steve Maloy will highlight sensitivity; Friedrich Schneider will cover orienteering and mime; and Arthur Miller will introduce a film which gives a sampling of the entire program.

I will turn now to measures of student attitudes, counselor attitudes, and interaction patterns.

Procedures

A random sample of 100 students were administered the Cheffers and Mancini Human Movement Attitude Scale (CAMHM) (Cheffers et al, 1976) which was used to obtain expressed attitudes of the children toward the physical activity program at Boston University itself. The scale, which has reported content validity and a reliability rating of .89, using the LERTAP computer program of the Hoyt Coefficient of Internal Consistency, was administered post test only.

To measure interaction, twelve children were selected by the schoolteachers as representative of each group; as having leadership impact with students in their respective schools. A trained observer used the Cheffers Adaptation of Flanders Interaction Analysis System (CAFIAS), which is a valid and reliable instrument designed to describe verbal behaviors, non-verbal behaviors, and interactions (Cheffers, 1972). A 10-minute random sample of each session of student behaviors and interactions with other students and their teachers was used for data analysis.

The sample consisted of:

Blacks:	2 girls 2 boys	All from Boston
Whites:	2 girls 2 boys	One each from Brookline and Boston
Orientals:	2 girls 2 boys	All from Brookline

Four major variables were analyzed:

1. The general patterns of interaction observed during the 10-minute samples taken each session;
2. The activities selected by the students each session;
3. The percentage of the total observation time evidencing student to student interaction; and
4. The predominant behavior(s) evidenced by the observed students during the 10-minute sample time each session.

To measure the effect of the camping experience, students and counselors were invited to complete a questionnaire designed to gain simple first-hand opinions on friendship, learning, and understanding towards disparate racial membership.

Results and Discussion

Table I provides a breakdown of the mean attitude scores for the CAMHM Attitude Scale, by school and race. The maximum possible score for the total instrument was 81.

TABLE I

Mean Post-Test Attitude Scores by School and Race

School	N	White	N	Black	N	Oriental
Brookline	24	62.5	3	62.9	21	61.6
Boston	17	61.9	27	63.0	8	62.4

N = number of students in group

The results seem to support the oft heard hypothesis that physical activity is an excellent medium to bring about effective reduction in racial tensions whilst at the same time offering constructive, enjoyable programs around which inter-ethnic harmony can be built.

The major patterns of interaction are included in Table II.

TABLE II

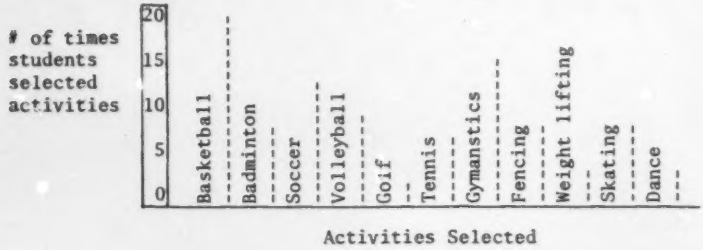
Major Interaction Patterns During Observation Periods

a. Extended student game playing or interpretation of teacher suggested activity.
b. Extended student practice of drills and other lead-up activities to games and skills.
c. Students standing watching activities, or sitting quietly.
d. Student listening to teachers giving information.
e. Students playing games with or strongly interacting with the teacher.
f. Students "flitting around."
g. Students interacting with other students.

The frequency of activities selected by the sample is described in Figure 1.

FIGURE 1

Activities Selected by Sample
(11 students over 8 weeks--10-minute observation)



The percentage of the total observation time evidencing student-to-student interaction is outlined in Table III.

TABLE III

Average Percentages--Student-to-Student Interaction by Activities

Basketball	(n=21)	=	12.88%
Soccer	(n=11)	=	12.08%
Gymnastics	(n=15)	=	8.73%
Volleyball	(n=9)	=	15.05%
Badminton	(n=8)	=	5.37%
Tennis	(n=5)	=	15.08%
Fencing	(n=3)	=	0.59%
Golf	(n=3)	=	4.09%

n=number of times activity chosen
Total % of Student-to-Student Interaction=9.75%

The predominant student behaviors during the 10-minute sample times are ranked in order of percentage occurrence (see Table IV).

TABLE IV

Ranking	Student Behavior	% of times behavior occurred
1	Playing games or developing skills	28.1%
2	Interacting with other children	15.7%
3	Standing around	15.2%
	Listening to teacher	15.2%
4	Practicing activity drills	14.6%
5	Playing games with or interacting with teachers	7.3%
6	"Flitting around"	3.9%

The overall interaction patterns indicate that students spent most of their time playing games, developing skills, or attending to basic drills necessary for skill acquisition. The students also spent time waiting around, watching, and listening to teachers giving information. The percentage of time recorded in this area is higher than was expected. It was noted that a reasonable amount of time (9.97%) was spent in meaningful student interaction through out all observations recorded.

Whereas the project administrators endeavored to phase basketball out as the semester progressed, pressure from the students brought about its reinstatement. At first glance, this appeared to be a failure for the program planners, especially in view of the addictive qualities that this game appears to have with inner-city blacks. However, basketball's potential for interaction was substantiated by the percentages recorded in the study. Basketball may denote a limited curriculum, but where the emphasis is on student interaction, it probably has a great deal to offer.

Fencing, golf, gymnastics, and badminton were found to offer low student interaction percentages. It is interesting to note that fencing received high commendation from outside observers, but failed to meet even minimal expectations of interaction.

Of interest, too, was the high percentage of student interaction recorded in tennis. As this game seeps through to all socioeconomic status groups, it may offer high potential for social interaction.

During this study, children were busily occupied playing games, developing skills, interacting with each other, and interacting with the teachers for part of the time (65.6%). Unproductive moments occurred 34.4% of the time. Administrators attributed the unproductive percentages to the personal choice nature of the program.

Open-ended responses to the questionnaire on the student attitudes towards integration at the residential field experience revealed that the students felt they could make friends among other races and did achieve a better understanding of other people (Table V).

TABLE V

Frequency of Student Attitudes Toward Achieving Integration

Question	White		Black		Oriental	
	YES	NO	YES	NO	YES	NO
Can you make friends with other races?	113	2	25	0	18	2
Did you discover anything new about other races?	54	55	16	9	14	6
Do you feel you understand people better as a result of Agassiz Village?	43	0	9	0	5	0
Do you feel you were able to make friends with people of other ethnic groups as a result of living together in a camping situation?	100	13	26	0	17	2

All questions were optional.

Eighteen counselors responded unanimously in support of the children's opinions. From the counselors' viewpoint, the almost unanimous reaction was that they had benefited immensely from living and working with the children.

Conclusions

1. Movement oriented integration programs do not destroy children's attitudes towards physical activity. Indications are that they have a positive effect on this variable.
2. Movement oriented programs appear to offer a safe and successful medium through which integration can occur.

In General

In general there are a number of observations I wish to make from a physical educator's perspective that have assumed critical importance to us in this continuing work:

1. Credibility--Our work has led to the kind of credibility with the school systems, the research community at Boston University and other schools and departments in and around Boston, that we have both shared and grown in stature as a result of the project. The very real opposition we have encountered from a handful of parents has added to our credibility and our self-image.
2. Responsibility--We have discovered at first hand the need to work closely with teachers in relation to program development and sensitivity in interaction with specific children, while at the same time we have discovered that teachers often know least about the real thinking of their students, especially if they are in antagonism to the judicial decree. We have confirmed the need to develop stronger, more specific, on-site testing instruments. The weaknesses of standardized tests have been indelibly scored.
3. Universities as Resources--The pairing of universities with school systems presents golden opportunities to build professional bridges, to develop programs, and to carry out better controlled research in the field setting. One of the truly delightful findings was the discovery that the ivory tower concept was remarkably ineffective amongst most of the university professors with whom we worked. Only a few proved to be inadequate.
4. On the negative side, we have found some foes. A handful of administrators, fellow professors, and politicians have been vociferous, vindictive, and volatile. And the more successful our ventures have become, the louder their antithetical cries have become....

Notwithstanding, this project will be continued in some form or another for as long as we believe it is feasible and effective.

Thank you.

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Self-Concept and Body Coordination Testing With Bi-Ethnic Groups

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The court-ordered mandate to desegregate Boston public schools was the result of an increasing concern from the black community to equate the quality of education for all ethnic minorities. This raised many concerns from educators and parents (predominantly white) on the true psychological values derived from integrating children from bi-ethnic backgrounds through school busing. Using education as an effective agent for this social change no doubt brought further questions regarding the whole morality of the busing issue. How would this affect the quality of Boston's educational system? Would busing only further crystallize the already existing hatred between blacks and whites? Most important, what changes in the present educational program would be needed to facilitate the process of integration?

Certainly the moral philosophies of integration are no less a concern for physical education than they are for other disciplines. Hence, the Magnet Movement Athletic Program (MMAP) grew out of a desire to help integrate the Boston public schools through an alternative educational program. Working under a thematic umbrella of movement, an attempt was made to utilize the concepts of physical activity as a means for achieving racial harmony. Additionally, the MMAP was designed to provide a movement-oriented program that would foster participation in a variety of activities within a group setting, and thereby create a greater awareness of each child's capacities and limitations. More important, the providing of new reference groups for the black and white child was to be an important outgrowth of the MMAP.

The entire program was sponsored by the Department of Movement, Health, and Leisure, Boston University. The purpose of the MMAP was to determine the feasibility of achieving integration among children from various cultural, ethnic and economic backgrounds by utilizing a divergent model of physical activity that would facilitate an easier assimilation of both black and white children. This model involved the use of perceptual motor activities which would allow for the development of specific motor skills. Midway in the semester, educational gymnastics were taught so that those specific skills that were initially developed could be integrated into more complexed movement patterns. During the entire time of the program all children were provided with opportunities to establish healthy and productive interaction.

In the final week of the MMAP, a living and learning situation took place at Agassiz Village in West Poland Springs, Maine. It was a residential camp experience that required cooperative participation by all the children. It was taught and supervised by trained teachers with help from supporting staff from the University.

Through all these activities of the MMAP, the child learned to clarify success and failure as well as have the opportunity to compare his own abilities with those of others. As a result, a child strengthens positive feelings about himself while developing new physical capabilities that will later be operational in his own environment.

It was thus decided that both physical and psychological components of the children should be assessed in order to determine the effects of the MMAP. Two prime components were subsequently established as measures for the evaluation of the effects of the physical activity program: self-concept and motor skills.

METHOD

Subjects

The subjects used in this study consisted of 344 elementary age children, grades one through five, from the Boston schools, Boston, Massachusetts. Children (N=230) from the Allston-Brighton and Mission Hill school districts represented the MMAP group, and children (N=114) from the Charlestown school district served as the control group. Both groups came from similar social, cultural and economic backgrounds. Furthermore, both groups came from schools that did not offer any type of formal physical education program. The purpose of the control group was to provide baseline data which would give more information concerning the effects of the MMAP.

Treatment

The MMAP group was provided with a formal physical activity program for 45 minutes once per week for ten weeks at Boston University. The curriculum consisted of perceptual motor and gymnastic activities. Because grades one through four did not participate in the residential field experience during the last week of the program, it was decided to look only at the effects of the physical activity portion of the program. The instruction was provided by nine graduate assistance from the Department of Movement, Health and Leisure of Boston University. The control group received no organized instruction. Each group had an equal proportion of black and white children.

Self-Concept Measure

The Martinek-Zaichkowsky Self-Concept Scale (MZSCS) was used to measure the self-concept of the elementary age children involved with the movement program. Since the MZSCS was validated with both English and non-English speaking children, it was preferred to existing self-concept scales because of the multi-lingual values, and because of the dissatisfaction with recognized instruments in the field (Piers-Harris, etc.).

Since the scale is non-verbal, it requires little or no reading ability. It consists of twenty-five items which measure various social, psychological, intellectual and physical components of a child's phenomenal self-concept. Since the MZSCS was initially developed and validated with multi-ethnic children, its use as a research tool has strong possibilities with similar children of dissimilar cultural backgrounds.

Motor Skill Measurement

The Body Coordination Test (BCT)(Schilling, 1974) was used to measure motor skill development. The test was originally developed and validated with German populations. The initial intent was to devise a measure which could diagnose young children with gross motor deficiencies.

The test consists of four sub-tests: 1) lateral movement; 2) lateral jumping; 3) one-foot hopping; and 4) dynamic backward balancing. All four sub-tests yield a total composite score which can be used for a general index of motor ability.

RESULTS

The independent variables of treatment group, race and grade, and dependent variables of body coordination and self-concept were analyzed using a 2 x 2 x 5 analysis of co-variance design (pre-test serving as the co-variate).

Motor Development and Self-Concept

A significant F ratio was only obtained for the main effects of treatment group, $F(1,323) = 5.37$, $p < .05$, and grade, $F(4,323) = 9.24$, $p < .01$. The adjusted means for the treatment and control groups were 168.78 and 162.66 respectively.

The treatment group's body coordination scores were significantly better than the control group's. In looking at the variable of grade, it was found that there was a linear improvement in body coordination scores for the five grades. The adjusted means for the five grades were 150.57, 166.16, 162.79, 174.31 and 178.11, respectively. The Duncan Multiple Range Test (Kramer, 1956) indicated that grades 2, 3, 4 and 5 were significantly better than grade 1 ($p < .01$), and that grade 4 was significantly better than grade 3 ($p < .01$).

There was no significant difference in body coordination scores between black and white groups. The two adjusted means for black and white groups were 166.62 and 166.82, respectively. However, a two-way interaction effect was found for grade and race $F(4,323) = 2.49$, p .05. Table 1 illustrates the race by grade breakdown for the adjusted means on body coordination scores. It was found that whites scored higher than blacks for the second grade samples. Inversely, fifth grade blacks showed greater improvement than whites.

Self-Concept

A significant F ratio was obtained only for the main effects of the treatment group, $F(1,323) = 10.482$, $p < .01$, and grade, $F(4,323 = 4.259$, $p < .01$. The adjusted means for the treatment and control groups were 22.79 and 21.82, respectively.

The treatment group's self-concept scores were significantly higher than the control group's. In looking at the variable of grade, it was found that grades 3, 4, and 5 were significantly lower in self-concept than grade 2. The adjusted means for the five grades were 22.87, 23.50, 22.00, 22.10, and 22.07, respectively.

There were no significant differences in self-concept scores between blacks and whites. Additionally, no interaction effects were detected. Table 2 illustrates the race by grade breakdown for the adjusted means on self-concept scores.

TABLE 1
GRADE BY RACE BREAKDOWN FOR ADJUSTED MEANS OF BODY CO-ORDINATION SCORES

	Grades					Over-all
Race	1	2	3	4	5	Mean
Blacks	150.58 (N=29)	160.12 (N=22)	161.59 (N=26)	174.55 (N=22)	186.96 (N=23)	166.62 (N=122)
Whites	153.18 (N=38)	170.71 (N=39)	163.54 (N=43)	173.44 (N=51)	173.19 (N=51)	166.82 (N=222)

TABLE 2
GRADE BY RACE BREAKDOWN FOR ADJUSTED MEANS OF SELF-CONCEPT SCORES

	Grades					Over-all
Race	1	2	3	4	5	Mean
Blacks	22.61 (N=29)	23.57 (N=22)	21.65 (N=26)	21.53 (N=22)	23.19 (N=23)	22.46 (N=122)
Whites	22.99 (N=38)	23.50 (N=39)	22.17 (N=43)	22.26 (N=51)	21.62 (N=51)	22.47 (N=222)

DISCUSSION

The results of the study add strength to the contention that the MMAP had a positive effect upon the development of motor coordination skills in young children from bi-ethnic backgrounds. These results are further supported by Rarick (1964) who feels that all pre-adolescent school children are in need of a physical education program in order to fulfill their need for physical activity. It is interesting to note that, although this program was offered only once per week, the activities and instruction provided were sufficient for positive developmental changes in both black and white youngsters to take place.

A significant increase in body coordination scores for grades 2, 3, 4 and 5 was also found. This linear increase is similar to those results reported by Zaichkowsky, et al (1976). It appears that the process of maturation has a definite effect on motor performance, along with the improvement derived from supplementary training experience. According to Eckert (1973) this is especially evident with tasks requiring gross motor movement as opposed to more complex tasks where training is a definite pre-requisite.

Although there was no significant difference in coordination skills between races for all five grades, it is important to note that both blacks and whites did show significant improvement over their counterparts in the control group. The interaction effect found between grade and race showed that whites improved more than blacks in the second grade, but that blacks performed better than whites in the fifth grade. These results are similar to previous studies by Hutinger (1959) and Lipe (1970) who found that black

children of similar ages performed better than whites in motor fitness measures. Still other investigators such as Harmon (1937) and Rhodes (1937) have reported negligible differences between the two races with respect to reaction time and motor ability.

In a sample of 5th and 6th graders, Rhodes demonstrated that the degree of white superiority is directly related to the complexity of the motor task. However, the fact that second grade blacks showed greater gains than whites, might throw some doubt on this conclusion. Perhaps both developmental and cultural factors may be an obtrusive variable causing grade and race interaction between those two age groups.

The results of the study also show that the MMAP had a definite effect on a child's self-concept. These results agree with those reported by Zaichkowsky et al (1976) and Gourley (1969), and Lewis (1972). The fact that both blacks and whites in the treatment group showed a significant increase in self-concept further illustrates that racially integrated classes can benefit from organized physical activity programs. It is also possible to assume that the social interactions between black and white children inherent in physical activity may further provide a healthier perspective on a child's social, cultural and ethnic ideals.

The significant decline in self-concept scores for both groups in grades 3, 4 and 5 suggests that early school pressures are interacting with the development of the child's self-concept. Zaichkowsky et al (1975) contend that such findings reflect the need for educators to place more emphasis on developing affective components in young children. Therefore, significant differences in self-concept between treatment and control groups would imply that there is a causal relationship between self-concept and participation in a physical activity program. However, the non-significant correlations between motor performance and self-concept fail to support this hypothesis. It appears that the development of these two variables is independent of each other. The results of this study suggests that a physical education environment should allow for the development of both variables, self-concept and body coordination, and that the development of one does not necessarily guarantee the development of the other.

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Examining The Social Distance of Multi-Ethnic Elementary School Children in Movement Oriented Settings

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The growth of social distance research has been interesting. It started with Emory Bogardus, who developed the first social distance scale in 1929. His primary research and interests were in measuring and comparing attitudes of various people and groups toward other national and racial groups. He accomplished this by asking each individual to respond to statements which indicated increasingly social distant feelings toward other individuals and groups. His scale was revised under great criticism in 1932 and refined to seven statements. His findings clearly indicate that racial out groups are rated more distant than members of the dominant group.

Bogardus continued this research into the forties and fifties when we find other researchers using his scale and also developing new scales.

Hartley, for example, in 1946 tested students in the degree of prejudice by creating fictional groups and finding that students who were generally prejudiced against out groups, were also prejudiced against fictional groups as well.

In the late 1940's, Blake and Dennis looked at social distance in regards to the race of young children and found that it was a function of age. Young children seem to assign more negative traits to out groups over all than older children.

In the 1960's, researchers like Triandis, Radke and Trager, modified Bogardus's scale, developed new questionnaires, and used interviews to discover the extent of social distance among elementary and college students. In each case their results primarily support those of Bogardus.

Following their lead, Georgoff and Epstein, manipulating the environment in various ways looked at social distance through the aspect of extended social contact. Their findings generally indicate minor positive effects through contact.

Horne in 1974 developed the Perception of Social Closeness Scale to indicate the social distance between teachers, pupils, and learning disabled pupils in various classroom interactions.

Michael Banton in his book, "Race Relations" has a further review of literature on social distance.

Reviewing these works indicate that most of these researchers agree with Banton when he said, "The value of the concept of social distance lies in the way in which it enables the research worker to evaluate the extent of discrimination and conceptualize it as a continuum."

It is with this idea in mind that I undertook the present study. Looking at social distance in movement settings is a unique way to try and create an environment that can enhance social closeness.

PROBLEM

The problem was to determine the extent of social distance among multi-ethnic children (White, Black, and Other) in different movement settings.

Hypotheses

1. There will be no significant change across treatment groups in the social distance of white, black and other elementary children who participate in movement programs in regards to race and sex.

A. There will be no significant change in the social distance of:

1. Whites with whites, blacks and others.
2. Blacks with blacks, whites and others.

B. There will be no significant change in the social distance of:

1. Black males with black males and females.
2. White males with white males and females.
3. Black females with black females and males.
4. White females with white females and males.

C. There will be no significant change in the social distance of:

1. Black males and females with white males and females.
2. White males and females with black males and females.

METHOD

Subjects

Subjects were 111 elementary school children (grades 4 and 5) from three elementary schools in Boston, Massachusetts. Children (n = 77) from District I served as experimental subjects and children (n = 34) from District II served as controls.

Both experimental and control groups came from identical social, cultural and economic backgrounds, and from schools which did not offer any type of formal movement programs.

Treatment

The first experimental school known as Laboratory School Program I, was given a movement program at Boston University, once a week for a semester. This program consisted of team and individual sport activities including swimming and skating, designed to provide an environment that would enhance the physical skills and the social skills of the participant.

The second Experimental Program was the Field Clinic Laboratory, administered to the other experimental school on the premises by Boston University students. The activities offered were elementary games, gymnastics and movement exploration, once a week for a semester. These activities were also designed to provide an atmosphere of relaxation and freedom to improve skills and aid social contact.

The Residential Field Laboratory Experience was given to both experimental groups for one week at Agassiz Village Camp in

Poland, Maine. During this experience the children participated in workshops of music and movement, dance, mime, orienteering, adventure activities and sport activities.

TEST APPARATUS AND PROCEDURES

In an effort to obtain precise measures on how each child felt toward his/her classmates, the Perception of Social Closeness Scale was used. (Horne, 1974.)

The test-retest reliability of each scale was determined by Horne when she administered the scale to 29 second graders on two consecutive days at approximately the same time. Students assigned a check to each other classmate therefore a total of 448 scale values were correlated. A Pearson r of .78 was obtained. This was significant at the .01 level.

The validity of this scale was established by administering the scale to 21 third graders. On the following day, the same children were asked to identify their best friends in the class. The number of times students were chosen was correlated with the number of times the student was checked on item one on the closeness scale (most close). The responses of the ten boys and eleven girls were tabulated separately. A spearman rank coefficient of .971 was obtained for the boys and a correlation of .772 for the girls. Both correlations were significant at the .01 level.

Scale Items and Values

Scale Value	Scale Item
.28	Would like to invite to my house.
.78	Would like to spend time with on the playground.
1.47	Would like to spend time with once in a while.
1.79	Would like to be more like other students.
2.68	Would like to leave me alone.

(Horne, 1974, p. 77.)

Thus an interval scale was created to measure the degree of closeness students and teachers felt toward class members.

Procedures for Collection of Data

During the first week of Laboratory School Program I, and the Field Clinic Laboratory, each child was given the Perception of Social Closeness Scale in their classroom. The control group was also tested at this time. Post-test measures were taken on all three groups at the end of these laboratories. Post post-test measures using the scale were taken following the individual residential field laboratories for the first two groups and the control was also tested at this time.

Design

The design was established by taking the hypothesis questions and manipulating variables in such a way as to directly answer the questions. Hence a design matrix was developed and placed over the newly created variables as shown below:

New Variables Created by A Priority Contrasts

		$\bar{X}$	Linear	Quad*	Sex D.*	Race D.*	Sex/OL*	Race/OL*
	WM	+1	-1	-1	+1	+2	-1	-2
	WF	+1	-1	-1	-1	+2	+1	-2
	BM	+1	-1	-1	+1	-1	-1	+1
	BF	+1	-1	-1	-1	-1	+1	+1
	OM	+1	-1	-1	+1	-1	-1	+1
	OF	+1	-1	-1	-1	-1	+1	+1
	WM	+1	0	+2	+1	+2	0	0
WHITE	WF	+1	0	+2	-1	+2	0	0
MALE	BM	+1	0	+2	+1	-1	0	0
RATING	BF	+1	0	+2	-1	-1	0	0
	OM	+1	0	+2	+1	-1	0	0
	OF	+1	0	+2	-1	-1	0	0
	WM	+1	+1	-1	+1	+2	+1	+2
	WF	+1	+1	-1	-1	+2	-1	+2
	BM	+1	+1	-1	+1	-1	+1	-1
	BF	+1	+1	-1	-1	-1	-1	-1
	OM	+1	+1	-1	+1	-1	+1	-1
	OF	+1	+1	-1	-1	-1	-1	-1

Key: WM--White male WF--White female BM--Black male
BF--Black female OM--Other male OF--Other female
$\bar{X}$--Mean Quad--quadratic function D--differential
OL--Occasions lines

Results

A significant effect over treatment groups was found with each racial group rating each other racial group more distant. Mean scores for each dependent variable over treatment are found in Table 1.

Table 1
Treatment

F-Ratio For Multivariate Test Of Equality Of Mean Vectors 1.8749
D.F. #14 And 184.000 P Less Than 0.0001

Variable	Hypothesis Mean SQ	Univariate F	P Less Than	Step Down F	P Less Than
x	1448.4966	17.6205	0.0001	17.6205	0.0001
sex d	999.6228	12.8939	0.0001	5.1059	0.0078
race d	378.6125	4.2750	0.0166*	2.6408	0.0765
linear	11.5173	1.6185	0.2035	0.5949	0.5537
Quadratic	98.9430	5.7486	0.0044	5.2953	0.0067
Sec. occ. L	5.6822	0.8613	0.4285	0.3991	0.6721
race occ. L	15.0469	1.8469	0.1632	2.2791	0.1082

Degrees of Freedom for Hypothesis #2.
Degrees of Freedom for Error #98.
*.05

A significant sex differential was found across treatment groups. Males rated males more distant and females rated females more distant, with a stronger distance rating existing among females.

F Ratios and Step Down data are found in Table II.

Table 2
Sex Differences

F-Ratio For Multivariate Test Of Equality of Mean Vectors #1.8749
D.F. #7 And 92.000 P Less Than 0.0827

Variable	Hypothesis Mean SQ	Univariate F	P Less Than	Step Down F	P Less Than
x	0.0036	0.0000	0.9948	0.0000	1.0000
sex d	490.0059	6.3205	0.0136*	6.9919	0.0096
race d	250.7474	2.8312	0.0957	2.3183	0.1312
linear	1.3343	0.1875	0.6660	0.2100	0.6479
Quadratic	8.7724	0.5097	0.4770	0.4122	0.5225
sex occ. L	2.6307	0.3988	0.5292	1.0586	0.3062
race occ. L	16.8324	2.0661	0.1538	2.0432	0.1561

Degrees of Freedom Hypothesis #1.
Degrees of Freedom for Error #98.
*.05

There was no significant race differential found across treatment groups.

The mean scores that reflect the results obtained are placed in the constructed design of this study, and found in Table III.

Table 3
Observed Cell Means

		White	Black	Other
School I	N	6	2	5
	$\bar{X}$	54.99	43.45	59.1
	Linear	.83	-4.30	-2.26
	Quadratic	1.9	7.7	.38
	Sex diff.	14.49	1.55	3.17
	Race diff.	-3.7	-10.55	-1.64
	Sex occ. L	2.1	-1.00	.26
	Race occ. L	-1.26	.95	-1.00
School II	N	11	10	6
	$\bar{X}$	62.86	53.94	54.9
	Linear	.86	-.82	.96
	Quadratic	.027	.46	-.23
	Sex diff.	13.51	14.52	16.04
	Race diff.	-3.21	6.13	-.86
	Sex occ. L	.627	1.36	2.86
	Race occ. L	.327	-.82	.01

Table 3 (Continued)

		White	Black	Other
	N	4	11	0
	$\bar{X}$	50.54	44.89	
	Linear	-1.25	-1.06	
Control	Quadratic	.15	-.77	
	Sex diff.	6.09	4.40	
	Race diff.	-11.62	-6.61	
	Sex occ. L	-.05	0.00	
	Race occ. L	.42	1.82	

Discussion

The results clearly indicate that participation in the experimental movement laboratories had an effect on the social distance by race of the two experimental groups. Although Table 1 shows that all groups rated other groups more distant, the control group over treatment rated each other considerably more distant. A glance at Table III for variable 5 across treatment indicates that had there been more time spent in these laboratories, social distance may have been significantly reduced. These findings are consistent with those of Georgoff (1970).

The analysis of race differential indicates that in truth non-significance is an important finding. The idea of the movement programs not catering to any one racial group is essential. Significance in this case would indicate prejudicial treatment during the programs.

The fact that the results show a significant same sex rating differential which is stronger than the opposite sex rating differential is puzzling at best.

Although developmentally children of this age usually exhibit same sex preference in regards to peers and playmates, and opposite sex aversions, some environmental stimuli may be even stronger. These stimuli may include the effects of bussing, extended teacher control, parental control and other pressures observed in the environment of schools in Boston. These pressures may create fewer choices for friendships, and therefore create across sex alliances. Other factors may be inherent in the procedures and scale itself, i.e. 1. giving a response that the teacher is looking for; and 2. function of the lack of scores in empty cells.

Overall the results indicate a further use of movement related experiences over extended periods of time may help to enhance the social interactions of different racial groups. They also show that the equality of participation offered in such programs is of the essence, to assure an environment where cooperation may flourish.

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Sensitivity to Movement and Human Environmental Programs With Multi-Ethnic Groups of Children

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INTRODUCTION

The term "environmental psychology" has recently been used to define the study of the interrelationship between the physical environment and psychological behaviors. This burgeoning interest in environmental psychology can be accounted for in part by the problem of the cities, i.e. overpopulation, pollution, and alienation of the individual.

While the behavioristic view of man as a series of stimulus-response connections with his environment is not acceptable, the ultimate influence of environmental factors on human behavior cannot be denied. Man is a product of his environment in the same manner as the environment is affected by man.

The question arises, will behaviors developed within a given environment persist if the environment is changed?

Research has shown that human behavior in relation to a physical setting is enduring and constant over time and situation. (Ittelson, Proshansky, and Rivlin, 1970). This viewpoint would seem to imply that behavioral change due to a different physical setting is transitory and contingent upon the maintainance of such a setting. Lewin (1951) indicates that the relationship is not so direct in that human behavior is a dynamic process resulting from continuous interaction of factors within the person with external factors as they are perceived by the individual.

Thus it would appear likely that behaviors developed within a hostile environment may be ameliorated by experiences within a different environment, such that upon returning to the original setting, the perception of the environment would be altered and the behaviors elicited would be different.

With this possibility in mind, a five day residential field experience was made part of a program of movement education offered to inner city school children in Boston during a period of enforced racial integration.

The description of program components, narrative experiences and behavioral outcomes follows.

CAMP PROGRAM

Imagine a child in the city whose horizon's extend no farther than his eye can see. What is his environment? It's composed of unequal measures of concrete, glass, exhaust, noise, strife, aggression, anxiety, and debris both human and otherwise. The individual functioning within such an environment is not concerned with growth but rather with the survival of his self-concept. Consequently, behaviors are shaped around aggression. He who takes, has. He who gives, has not.

In order to see if such patterns of behavior could be changed by a change in the environment coupled with a program of

group movement experiences, a group of students from the city were transported to Agassiz Village, Maine for a five day residential field experience as part of their school curriculum.

The environment there was radically different and unfamiliar to most of the children. Where there was concrete, now there was soil. Where there were tall buildings and pollution, now there were trees of all shapes and sizes and clear skies. Where there was the cacophony of man, now there was the peace of nature. (Punctuated of course by the whoops of the newly liberated). The only similarity between this environment and the one they left was the fact that these were the same children that had been embroiled in racial strife. The stage was set for the culminating activity, a group living experience.

A camp program is not a schedule of times or a roster of events. It's what is actually happening and all that was happening at Agassiz Village related to a central theme which was based on the book, The Forest of the Night, by John Rowe Townsend.

There were six program components which ran the gamut from artistic experiences through heavy physical activity. All program components related generally to the theme of the book, which involved a young boy in search of self, and specifically to the environment and its effect on each child individually and on the group as a whole.

The children took part in dramatics wherein they adapted sections of the book and performed them in a living theater. They were also exposed to various art forms and encouraged to express themselves and their view of the characters and situations in the book through at least two different mediums.

Relating to the environment and paralleling the experiences in the book, the children became involved in four additional components. First, they were taught map reading, compass orientation, specialocomotor skills in a program of orienteering which utilized concepts from the book as clues and gave them the ability to move safely through the natural environment. Then they invaded the environment and explored both the durability and inevitability of nature, and the factors involved in the human invasion of the natural environment. They were encouraged to open their senses and to try and experience as much of what nature was showing them as possible.

Next, the children tried to copy the natural environment by exploring apparatus designed by man to take its place. This involved activities on a low ropes course and other adventure experiences which placed a premium on the development of personal confidence and group success obtained by conquering a risk situation.

Finally, the children attempted to take what they had experienced and use their knowledge to change the environment to a different, useful condition without permanently disturbing it. This was accomplished through the development of games in which the children set their own rules, devised their own strategies, and developed their own equipment from material which nature provided.

All six components were designed to challenge the children and promote cognitive, social, emotional, spiritual, and physical growth. The key was in the creation of an environment which would nurture positive growth within a group rather than promote the alienation of individuals.

One area of the program which had the potential for demonstrating change was the invasion of the natural environment. This exercise in sensitivity was performed in two parts; a daytime nature walk and a night hike. The children were removed from that which was familiar and encouraged to experience and be sensitive to a non-threatening natural environment.

The land surrounding Agassiz Village is a dense forest and one can walk for a good mile without encountering obvious signs of human habitation. However the children were to make many discoveries about this "wilderness."

Before entering the forest, the children were asked to do three things. First, they were to use all their senses; second, they were to look for cycles which might be occuring in the environment; thirdly, they were to be alert for signs of intrusions into the environment whether manmade or natural.

Cycles were noted visually in the different levels of the forest, in the growth and decay of plant life, and in the symbiotic relationship between the woodpecker and the trees. They touched the vegetation and learned to identify a tree based on its texture. They listened and heard the screech of the owl, the rustle of the field mice, and most persistently, they heard the intrusion of man. The sounds of powerboats on the lake and trucks on a highway miles away were constantly overwhelming the language of the forest.

Intrusions were further noted in the many tree stumps left by the loggers, in the stone walls which crisscrossed the forest, in the damage caused by a tornado, and in the presence of a pile of household garbage found right in the middle of the forest. This provided one of the most interesting and significant examples of sensitivity that we could have hoped for in that not one of the groups noticed or made any mention of this obvious intrusion! This phenomemnon is readily explained by the fact that any stimuli of a given intensity if continuous will tend to disappear from our perception. When placed within the forest environment, although the children were intent on seeing, hearing, smelling and touching everything, they took no notice of the garbage.

These day walks were truly enlightening and the children usually spread themselves out over an area and celebrated each new discovery with cries that would have made Columbus proud. The night hikes were another story.

Prior to leaving on a night hike the group was told about nocturnal animals and their special adaptations which afford them the ability to see in the dark and to hear very well. They were asked to become nocturnal animals and to move silently through this nighttime environment with their eyes and ears open. The area that was traversed was the same as that experienced on their nature walk but the procedures and responses were quite different.

The entire group held hands as they moved off about 400 yards into the forest to the sight of an old logging road. What had been a boisterous bunch of conversationalists quickly became a silent majority as they progressed deeper into the forest. The first designed experience required the group to sit silently for ten minutes and listen to the undisturbed forest. This was difficult at times as rampaging imaginations created various beasts which prowled very nearby, but nonetheless, after a few minutes the forest sounds became apparent and the children began

to appreciate the abundance of life nearby which had heretofore been hidden. The second experience was an opportunity for the children to emulate the nocturnal animals as half the group moved down the trail and sat down a few yards off the trail while the rest followed a few minutes behind and attempted to locate their friends solely by sight and sound. Most groups failed to locate the other people which further brought home the concept of natural adaptation.

The final designed experience was a 50 yard solo walk down the trail. This activity provided the individual with a personal risk which was tempered by the support provided by the group. For example, one boy who was a leader in the daytime activities was more than a bit hesitant to try the solo. After he had seen a few of the others had gone and survived, he casually sauntered off down the trail. However, after a few seconds, his casual steps increased until he broke into a full sprint and thundered down the trail into the arms of the group who heartily congratulated him for his effort.

Upon their return to the camp, the group discussed their feelings during the experiences and attempted to relate these feelings to those experienced by the boy in the book and to their life in the city. Their comments were insightful; one particularly which was made in reference to the stated fears of one member regarding the night walk, which was, "you don't have to be afraid man, you're with us!"

SUMMARY AND CONCLUSIONS

The indentification of behavioral change in the context of this report must be purely subjective since objective measurements relating to self-concept, body coordination, and social distance are the domain of my colleagues. Nonetheless, since the children had been observed in both the city and natural environments over a period of two years, these subjective findings would appear to have some validity.

Within the city environment, a definite cluster effect existed. Blacks tended to stay together as did whites, orientals, etc. While comaraderie existed within the groups, there was little interaction between them and behaviors evidenced were usually aggressive, exclusive, and highly competitive. The situation was effectively static, and it appeared that the groups were satisfied with separate coexistence. Since such a status enabled the schools to function, little effort was made by administrators to break down group barriers.

While the cluster effect was noticeable in the early hours of the camp experience, the barriers were not. This was a function perhaps of the camp organization which divided the population into three groups with equal representation by school within each group and effectively provided the initial crack which opened the door for positive interaction. The children were receptive to the new experiences, commented readily on their perception of the relationships observed, and increasingly evidenced support within the group rather than aggression.

This last observation was indeed an obvious indication that behaviors were changing during the camp experience and, if transferrable to the city environment, could provide the beginning of a new era, a new environment, for the city.

It will be necessary to measure attitudes and group behaviors within the schools to objectively determine whether behaviors which were obviously changed in the camp environment were retained and evidenced in the city.

AVENUES FOR FURTHER RESEARCH

It would be of interest to determine the effect of process versus physical setting. Would the behavioral changes developed within the natural environment have occured if the same program components were administered within the familiar city environment?

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The Factor Structure of the Motor Domain of Trainable Mentally Retarded Children and Adolescents

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The theoretical frame of reference of this investigation rests on the premise that underlying the many fine and gross motor skills that children acquire there are certain well defined general components of motor behavior that are needed for their execution. The nature and extent of use of such components varies with the skill and the way in which it is performed. There is a considerable body of evidence which indicates that there is a well defined factor structure of motor abilities in adolescents and adults, and more recent research has yielded similar findings with children at the primary and pre-school age levels. Such general motoric components loosely defined as muscular strength and power, balance, speed of movement, agility, manual dexterity, flexibility, and coordination have been characteristically identified in these investigations.

More recently the writer and his colleagues have been interested in determining if there is also a well defined factor structure of motor abilities in mentally retarded children and adolescents. This led to a study (Rarick, Dobbins and Broadhead, 1976) in which 47 anthropometric and motor performance measures were administered to some 400 normal and educable mentally retarded children in the San Francisco Bay area. The results yielded factor structures which were essentially the same in the intellectually normal and the retarded children, factors which were strikingly similar for both sexes. Four factors accounted for the major proportion of the variance in the above groups. These were tentatively identified as (1) Strength-Power-Body Size; (2) Body Fat; (3) Fine Visual-Motor Coordination; and (4) Gross Limb-Eye Coordination.

The present study is an extension of this earlier investigation using for the most part the procedures that had proved to be effective there. Its purpose was twofold, namely (1) to identify the basic components of fine and gross motor behavior of trainable mentally retarded individuals in the age range 6 through 21 years using factor analytic procedures, and (2) to determine the extent to which the factor structures of motor abilities of the trainable mentally retarded differed according to age level and sex.

Procedures

The investigation involved a total of 453 trainable mentally retarded individuals, both home reared and institutionalized, residing within 50 miles of San Francisco. The means and standard deviations of the chronological ages of the eight age-sex groups are given in Table 1. The mean IQ's of the groups were quite similar, ranging from 35.6 to 41.3.

The hypothesized factor structure which was formulated in the earlier research on normal and EMR children and which provided the conceptual base for the selection of the test items there was employed here as were many of the tests which were used in that

Table 1. Means and Standard Deviations of Chronological Ages in Years and Months of the Subjects According to Age Groups

	Males			Females		
Age Groups	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.
6-9[11]	42	8.23	1.13	27	8.55	1.01
10-13[11]	68	12.11	1.15	55	12.13	1.03
14-17[11]	87	15.89	1.20	64	16.01	1.28
18-21	65	19.56	.85	45	19.58	1.01

investigation. The hypothesized factor structure included ten motoric and two morphological components, namely (1) Static Muscular Strength; (2) Explosive Muscular Strength; (3) Muscular Strength-Endurance; (4) Gross Body Coordination/ (5) Cardio-Respiratory Endurance; (6) Limb-Eye Coordination; (7) Manual Dexterity; (8) Balance (Static); (9) Flexibility; (10) Balance (Dynamic); (11) Body Fat; and (12) Body Size. The rationale for inclusion of the morphological measures is that many gross motor abilities are dependent to varying degrees upon body weight and body structure.

Data from some 45 motor performance tests and eight measures of physical growth constituted the basis for the factor analytic procedures. A complete description of the testing procedures has been reported elsewhere (Rarick and McQuillan, 1977). Intercorrelations among all variables with chronological age held constant were run separately by age group and sex* and the residual intercorrelation matrices factored using three initial solutions. The initial component and factor methods included the Incomplete Principal Components (Hotelling, 1933), Alpha (Kaiser and Caffrey, 1965) and Rao's Canonical Factor Analysis (1955).

The above three factor analytic methods provide two component solutions (Incomplete Principal Components and Rao's Canonical), each having a statistical base, and one factor solution (Alpha) with a psychometric base. Orthogonal solutions employed the Kaiser normal varimax procedures (Kaiser, 1958) in each of the three initial solutions. In all oblique solutions the default value was set at zero.

The approach used in identifying the factors that were common across the six solutions followed closely that outlined by Harris and Harris (1971). The procedure rests on the premise that there should be substantial agreement among the several solutions in respect to the commonality of variables that load on a given factor. This necessitated the selection of one derived solution to be used as a template against which the factors of the remaining five solutions could be compared for similarity on the basis of a similar profile of factor loadings. The incomplete principal component solution with varimax rotation was chosen as the starting base because it included more variables with substantial loadings on a particular component than any other derived solution.

Beginning with the first rotated factor in the incomplete principal component solution, a search was made among the five remaining derived solutions for a factor in each solution that was similar to it with reference to the pattern of factor loading.

*The data for the youngest age level of boys and girls were pooled since the N's by sex were not sufficiently large to run separate factor analyses.

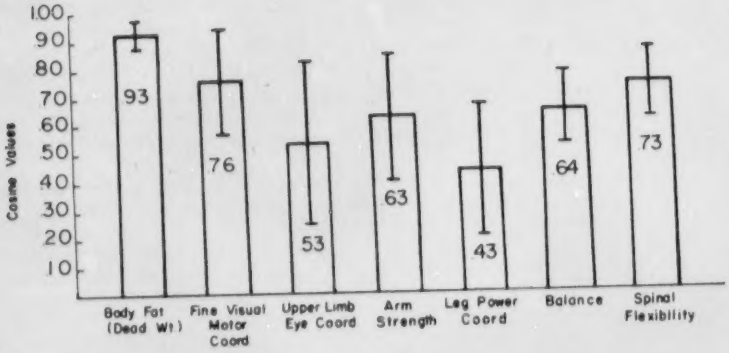
Once this was accomplished, this factor was eliminated from future searches. Following the same procedure, subsequent searches were made for additional factors --- specifically, those in which the loadings on the other five derived solutions were similar to the loadings on the incomplete principal component solutions. Thus, the identification of factors common to the six derived solutions yielded what have been called comparable common factors, comparable specific factors, and noncomparable factors. For the purposes of this study, a comparable common factor was defined as one having three or more variables with rotated loadin greater than .40 on at least four of the six derived solutions. A comparable specific factor was defined as one having one or two variables with loadings greater than .40 on at least four of the six derived solutions. A noncomparable specific factor was defined as one that did not have at least one variable with loadings of .40 or higher on at least four of the solutions.

The procedure employed for assessing similarities and differences among the factor structures of the several groups of subjects followed the method developed by Kaiser, Hunka and Bianchini, 1971. The procedure was applied to the orthogonally rotated Incomplete Principal Components solution, thus providing a quantitative estimate of the similarity among the respective comparable common factors and comparable specific factors of all groups of subjects. The resulting coefficients are not correlation coefficients per se; rather, they are cosines between factor axes, the latter identifiable by the definers (factor loadings) within the respective comparable common and comparable specific factors in each subject group. They can, however, be conceptually interpreted as correlation coefficients with a theoretical range of 1.00 to -1.00.

Results and Discussion

The number of comparable common factors extracted from the intercorrelation matrices of the seven age-sex groups of TMRs ranged from six to nine and the number of comparable specific factors from one to five. Seven factors as identified by their patterns of factor loadings were common to all seven groups, accounting in each instance for a major proportion of the within group variance in motor performance. These factors were tentatively identified as (1) Body Fat or Dead Weight; (2) Fine Visual-Motor Coordination (3) Balance; (4) Upper Limb-Eye Coordination; (5) Arm Strength; (6) Spinal Flexibility; and (7) Leg Powr-Coordination. Thus, the factor structure as hypothesized was not entirely supported by our results. No factor of cardiovascular endurance emerged, nor was there a differentiation between static and dynamic balance, nor was strength clearly separated into static, dynamic, and endurance components. Nevertheless, there were clearly identified factors, which by visual inspection of the respective factor loadings suggested a similarity of factor structure among the seven groups.

The above is borne out by a quantified comparison of the factor structures of the seven groups following the procedure described earlier. Figure 1 shows the similarity of the factor structures of the seven groups as reflected by the means and standard deviations of the cosines derived from the factor axes of the seven comparable common factors. The means of the cosines ranged from a high of .93 for Body Fat to a low of .43 for Leg Power-Coordination. While the cosines within factors did vary some by age-sex groups



Factors

1 Body Fat (Dead Weight)
2 Fine Visual-Motor Coordination
3 Upper Limb-Eye Coordination
4 Arm Strength
5 Leg Power Coordination
6 Balance
7 Spinal Flexibility

Definers

Weight, Subscapular Skinfold, Triceps Skfd., Abdom Skfd
Minnesota Manipulative Preferred and Non-Preferred
Target Throw Horizontal-Target Throw Vertical (6 groups)
Elbow Flexion, Elbow Extension
Bike and Res., Bike and No Res., Bike 90 (6 groups)
Railwalk Sde., Railwalk Bckd., (Stork Std. & Rail Fd., 6 groups)
Lateral Spinal Extension (Spinal Extension 6 groups)

Figure 1. - Similarity of Factor Structures of Age Grouped TMR Boys and Girls As Reflected By the Means and Standard Deviations of the Cosines of the Factor Axes

the standard deviations of the cosines were low to moderate with the exception of Upper Limb-Eye Coordination and Leg Power-Coordination. It is evident on the basis of the magnitude of the cosines among subject groups and the general similarity of the definers of the respective factors that there is considerable similarity of the factor structure among the seven groups of subjects.

Considerable confidence can be placed in the results in view of the marked within group agreement in the findings coming from the six separate factor analyses used with each of the seven age-sex groups. The criteria which were set for identifying factors as comparable common factors were rigorous, namely three or more identical variables with rotated factors loadings of .40 or higher on at least four of the six solutions. This to a large extent ruled out the possibility of biasing the results because of the factoring techniques used. Similarly, the criteria employed for defining the comparable specific factors was in no sense loose, namely one or two identical variables with loadings at or above .40 on at least four of the six solutions.

The substantial similarities in factor structures among the seven groups of these subjects should not be too surprising for children are anatomically much alike regardless of observable differences in size and body build. Their lever systems and the muscles which activate these systems do not differ materially, and if the task is not overly complex and if its requirements are well understood, it will ordinarily be done in much the same way by most children. The end result is for the most part dependent on refinements in the timing, application and control of muscular force.

The findings reported here provide substantial evidence that there is a well defined factor structure of motor abilities of TMRs in the age range 6 through 21 years, one that is remarkably similar for males and females of varying chronological age. The

general similarity of the factor structure of this group of TMRs to that previously reported on EMR and intellectually normal chidlren is worthy of note.

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Discriminating Power of Motor Performance Variables Relating to the Factor Structure of TMR Children and Adolescents

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The purpose of this paper is to present a section of the findings embodied in the more comprehensive report by Rarick and McQuillan (1977). One of the principal functions of this investigation was to develop tests appropriate to the assessment of motor performance of trainable mentally retarded individuals.

Some 45 motor performance tests were administered to 453 TMR males and females in the age range 6-21 years. Subjects were classified in age categories within sex as follows: 6-9^{11} years (youngest), 10-15^{11} years (young), 14-17^{11} years (old), 18-21^{11} years (oldest).

The first major step was to determine the factor structure for each of the age-sex categories so that suitable definer variables could be identified. (Findings of this section of the report are presented in more detail in a companion paper.)

Among the several criteria acknowledged as being essential to valid test construction, test item discrimination is not the least important. There is an established body of normative data available which attests to the fact that increases in age are accompanied by development in growth and physical maturity and that there are certain critical periods when males differ appreciably from females, age being held constant. It is on such a premise, the reliability of age and sex related norms that is, that test discrimination between age groups (within sex) and between sexes (within age) serves as a validation procedure. It was for these reasons that discriminant analysis was employed to determine which of the common definers would best assign members of the contrast groups to their appropriate age or sex category.

Through the use of discriminant analysis a distinction may be made between two or more groups with respect to certain common characteristics. In this study the groups involved were a) the four adjacent age categories within each sex, and b) each sex category within the four respective age levels, the discriminatory variables being the motor performance measures which defined the comparable common factors. As indicated by Kerlinger (1973) discriminant analysis is essentially a multiple regression situation in which the dependent variable represents group membership and the independent variables are the measures considered to have discriminating power. Where there are but two contrast groups, these are assigned respective values of 1 and 0 (the dependent variable), and the discriminating measures are incorporated as the independent variables. A stepwise, multiple regression is then solved in the customary manner.

To determine the best combination of variables a stepwise procedure is adopted which orders the variables in terms of the relative contribution of each towards maximizing the separation of the groups. Thus, the first selection is the variable which maximizes the F ratio and the second selection the variable which, in conjunction with the first, best improves the initial discrimination. The remaining variables are selected similarly, that is in

accordance with the potential of each to make a statistically significant contribution to further improve, and ultimately maximize the separateness of the contrast groups.

In all, 10 such analyses were performed; 4 for the male-female comparisons within age groups and 6 (3 male, 3 female) adjacent age comparisons as follows: youngest-young, young-old, old-oldest.

Results

The results of the analyses are presented in tabular form showing variables ranked according to entry. The percentages of subjects correctly classified in each of the two contrast groups and the total percentages for the groups combined are indicated. The changes generated by the addition of any one variable may be assessed by the effect on the three cumulative totals.

Between Sex Comparisons. Lack of space prohibits presentation of the regression analyses complete but Table 1 indicates the extent to which 5 definers correctly assigned male and female subjects to their appropriate sex categories. With the youngest boys and girls it may be observed that 5 motor performance definers correctly classified a total of 82 percent of the boys and girls into their respective sex categories, namely 83 percent of the boys into the male category and 81 percent of the girls into the female category. Six definers were required to maximize the total percentage of subjects correctly classified (84%). The 5 definers represented 4 of the 6 factors, namely Leg Power-Coordination, Upper Limb-Eye Coordination, Arm Strength, and Fine Visual-Motor Coordination. With the young boys and girls the separation with 5 variables was less marked than with their younger counterparts. Eighty percent of the young boys were correctly classified and 73 percent of the young girls. The 5 definers yielded a total of 76 percent of the subjects correctly classified but 10 definers were required to raise this percentage to the total of 80%. It was noticeable that 3 of these definers were from the Leg Power-Coordination factor, the remaining two variables representing Fine Visual-Motor Coordination and Arm Strength.

It required 9 definers to maximize separation between the old boys and the old girls, the total separation accounting for 80 percent of these subjects. Whereas five definers correctly classified 83 percent of the boys only 63 percent of the girls were correctly assigned by the same definers. The total separation included 74 percent of the subjects and involved definers from 4 of the 6 factors.

In the case of the oldest groups of boys and girls, maximum separation was realized with 8 definers; 87% of the subjects being appropriately placed. Five definers provided markedly good separation, 85 percent being correctly identified as males and 76 percent correctly assigned as females, the total accounting for 81 percent of the subjects. Three factors were represented by these 5 definers, 3 of the latter being measures of Fine Visual-Motor Coordination.

Adjacent Age Group Comparisons (Males). The three analyses involving the TMR male subjects are presented in Table 2. In separating the youngest from the young group maximum separation was achieved with as few as five definers. The total correctly placed with these 5 definers was 89%, 83% of these were youngest males correctly assigned to the youngest group while 93% were young males also correctly classified. It is worthy of note that these 5 definers

(representing factors of Upper Limb-Eye Coordination, Leg Power-Coordination and Arm Strength) yielded separation as effectively as did all 16 of the common definers which were entered into the stepwise analysis.

In the comparison involving young and old male subjects one definer from the Arm Strength factor, one from the Upper Limb-Eye Coordination factor and 3 definers representing the Leg Power-Coordination factor combined in the order given to yield a separation involving 78% of all the male subjects. Of these, 72% were assigned correctly to the young category and 83 percent were correctly nominated as members of the old category.

Five variables, in the case of the old and oldest groups of males, provided no better than a 71 percent correct classification. Although 84 percent of the old group were assigned correctly, a mere 54 percent, a little more than half, of the oldest boys were determined to belong to their appropriate age category. Nine definers raised the effectiveness of the separation to maximum with a total of 80 percent correctly classified. Ninety-one percent of this total pertained to the old group, but only a relatively low 66% were accurately identified as being in the oldest age group.

Adjacent Age Comparisons (Females). In Table 3 the findings of the adjacent age group comparisons for the females are presented.

For the youngest and the young TMR girls four definers created maximum separation of the subjects into their respective age levels. These four definers (2 from the Upper Limb-Eye Coordination factor and one each from the factors of Balance and Flexibility) correctly assigned 89% of the youngest and 93 percent of the young girls to their respective age categories. In all, 92 percent of the subjects were classified correctly.

It required 7 definers to reach maximum differentiation of the young and old groups of females, 85 percent being classified accurately. Using five definers 82 percent of the young girls were properly classified and 81% of the old. For these subjects the combined percentage was 82, the 5 definers employed each representing a separate factor. Leg Power-Coordination was the only factor not included in the analysis at that stage.

In the final discriminant analysis, which featured the old girls and the oldest girls, 6 definers obtained the most effective separation of subjects according to age category (81%). With five definers 76% of all subjects were correctly classified of which 84% were properly categorized as belonging to the old group, but a relatively low figure of 64 percent being identified as oldest girls. Again, 4 of the 6 factors were represented, these variables belonging to the factors Arm Strength, Upper Limb-Eye Coordination, Fine Visual-Motor Coordination and Flexibility.

Comments

It is clear from the results of each of the ten analyses that a relatively few of the total variables entered provided substantial discriminating power. In the analyses involving subjects in the young, old and oldest categories from six to ten definers were as effective in maximizing discrimination as 16 to 30. Where the youngest and young groups were featured this was even more striking for as few as 4-6 variables provided maximum separation in these 3 analyses.

For the between-sex discriminations and those analyses addressed to assigning males to appropriate age groups, the predominant variables were from the factors Leg Power-Coordination, Arm Strength,

Table 1. Percentages of Male and Female Contrast Groups Within Age Level Separated into Correct Classification Groups by Stepwise Discriminant Analyses (5 Definers Shown)

Youngest Boys (N=42) and Girls (N=27)

Definers	Boys	Girls	Total %	p Value
Bike w/Res.	64	74	68	.01
Tgt. Vert.	76	75	68	.08
Tgt. Cir.	83	70	78	.00
Elb. Flex.	83	70	78	.03
Minn MP	83	81	82	.03

Six definers needed to maximize total % correctly classified (84%)

Young Boys (N=48) and Girls (N=27)

Definers				
Elb. Ext.	51	73	61	.01
Bike w/Res.	76	56	68	.00
Bike w/o Res.	76	65	72	.00
Sr. Bd. Jump	78	71	75	.00
Minn MP	80	73	76	.02

Ten definers needed to maximize total % correctly classified (80%)

Old Boys (N=87) and Girls (N=64)

Definers				
Grip Rt.	57	63	60	.00
Bike 90	75	56	67	.00
Tgt. Cir.	83	54	71	.00
Tgt. Vert.	93	59	73	.00
Ring Sit.	93	63	74	.01

Nine definers needed to maximize total % correctly classified (80%)

Oldest Boys (N=65) and Girls (N=45)

Definers				
Elb. Flex.	72	82	76	.00
Purdue	80	80	80	.00
Ring Sit.	83	80	82	.00
PR #10	83	78	81	.016
Bike w/o Res.	85	76	81	.05

Eight definers needed to maximize total % correctly classified (87%)

Table 2. Percentages of Adjacent Age Categories (Males) Separated into Correct Classification Groups by Stepwise Discriminant Analyses (5 Definers Shown)

Youngest (N=42) and Young (N=48) TMR Boys

Definers	Youngest	Young	Total	p Value
Tgt. Cir.	78	72	74	.00
Bike w/Res.	64	91	81	.00
Elb. Flex.	74	88	83	.00
Tgt. Vert.	86	90	88	.00
Ring Sit.	83	93	89	.00

Five definers achieved maximum separation

Young (N=48) and Old (N=87) TMR Boys

Definers	Young	Old	Total	p Value
Grip Rt.	54	59	70	.00
Tgt. Cir.	71	74	74	.00
Bike w/o Res.	71	80	76	.00
Bike w/Res.	46	84	76	.03
Bike 90	72	83	78	.01

Seven definers needed to maximize total % correctly classified (79%)

Old (N=87) and Oldest (N=65) TMR Boys

Definers	Old	Oldest	Total	p Value
Bike 90	78	52	67	.00
Zig Zag Run	83	42	65	.00
Grip Rt.	84	46	68	.01
Golf Ball	80	52	68	.01
Ring Sit.	84	54	71	.01

Nine definers needed to maximize total % correctly classified (80.3%)

Table 3. Percentages of Adjacent Age Categories (Females) Separated into Correct Classification Groups by Stepwise Discriminant Analyses (5 Definers Shown)

Youngest (N=27) and Young (N=55) TMR Girls

Definers	Youngest	Young	Total	p Value
Tgt. Cir.	85	71	76	.00
Tgt. Vert.	85	93	90	.00
Stork	81	93	89	.00
Lat. Sp. Ext.	89	93	92	.01
Bike w/Res.	89	91	90	.00

Four definers needed to maximize total % correctly classified (92%)

Young (N=55) and Old (N=44) TMR Girls

Definers	Young	Old	Total	p Value
Tgt. Hor.	71	78	75	.00
Elb. Flex.	73	88	80	.00
Ring Sit.	76	86	82	.00
Rail. For.	78	81	80	.01
Lat. Sp. Ext.	82	81	82	.00

Seven definers needed to maximize total % correctly classified (85%)

Old (N=44) and Oldest (N=45) TMR Girls

Definers	Old	Oldest	Total	p Value
Grip Left	66	64	65	.00
Tgt. Hor.	84	60	74	.00
Ring Sit.	86	56	73	.00
Elb. Flex.	88	62	77	.01
Lat. Sp. Ext.	84	64	76	.01

Six definers needed to maximize total % correctly classified (81%)

Upper Limb-Eye Coordination, and Fine Visual-Motor Coordination. In regard to the analyses purporting to assign females to their appropriate age groups, definers representing five factors were the main contributors. These were: Upper Limb-Eye Coordination, Balance, Flexibility, Fine Visual-Motor Coordination, and Arm Strength; Leg Power-Coordination not being represented.

It is of interest to note that the definers were more limited in determining the group membership of the subjects in the old and oldest age groups (within sex) and this may be a reflection of arrested growth and development in the oldest subjects. In contrast, the discrepancy between the youngest and young groups was more striking probably reflecting the acceleration in growth and motoric ability which arrives with and continues to develop through puberty.

It will be recalled that the purpose of the discriminant analyses was to aid the investigators in selecting the most appropriate test items to constitute the motor performance testing battery. First priority was given to the items with high loadings on comparable common factors. Additional requirements were concerned with a) the commonality of the items across age and sex groups, b) reliability, c) independence as reflected by low item intercorrelation, d) test item discrimination, and e) feasibility and ease of administration.

The items eventually selected were: Minnesota Manipulative Test, Railwalk Sideways, Target Throw Horizontal, Elbow Flexion Strength, Lateral Spinal Extension, and Bicycle with Resistance.

In view of the large number of common definers which was entered in the analyses (as many as 30 in some cases) the regularity with which the same definers (or those very similar in nature) appeared in the various comparisons was convincing. In six of the analyses at least two items from each of the six common comparable factors showed statistically significant discriminating power at the .05 level of confidence. Only in one instance, old boys versus old girls, was the absence of such an item noticeable.

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Strength and Flexibility in Down's Syndrome Children

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Down's syndrome (DS) children differ from their non-retarded peers on several dimensions of physical growth and motor functioning. Short stature, hypotonic musculature, and hypermobility of the joints are symptoms of DS children which are not characteristic of normal children (Moore and Moore, 1977). Previous research has shown that the substandard height of DS children persists throughout their lifespan, and that this stunting is due to proportionately short lower extremities (Rarick and Seefeldt, 1974; Thelander and Pryor, 1966). Research findings regarding hypotonicity and hyperflexibility are less clear than data regarding stature.

Clinical findings suggest that deficiencies in muscle tone are characteristic of DS infants (Penrose and Smith, 1966); however, Cowie's (1970) report indicates that muscle tone improves with age in these children. Evaluation of postural reflexes and muscle palpitation revealed that all 79 mongol babies in Cowie's sample exhibited persistence of immature postural reflexes and poor muscle tone. Both muscle tone and posturing improved throughout the first two years of life, a finding which casts doubt that hypotonicity is characteristic of older DS children. Clinicians have also reported hyperflexibility of the joints in DS children (Moore and Moore, 1977; Nelson, 1969); however, it is unclear whether this hyperflexibility is due to inherent differences in joint structure or to lack of muscle tone. Clearly data are needed to elucidate the nature of hypotonicity and hyperflexibility in these children.

In previous studies, researchers have typically contrasted DS children with non-retarded samples to determine the extent of hypotonicity and hyperflexibility. The differences which emerged in these past studies may not be attributed wholly to etiological condition, but may in part be related to lack of motoric experience characteristic of most mentally retarded children. This investigation was designed to determine if in fact DS children differ from non-differentiated TMRs on such motoric functions as muscular strength and extent flexibility. Since the TMR sample is generally comparable to the DS population in intellectual status and motor learning experiences, this comparison will help determine whether hypotonicity and hyperflexibility are related to degree of retardation or are specific to DS children.

The hypotheses advanced in the present investigation were these: (a) DS children were expected to exhibit less strength than non-differentiated TMRs at all age levels on tasks requiring muscular strength and speed of movement. (b) Since extreme flexibility is often associated with deficient muscle tone and because clinical observations indicate hyperflexibility among DS children, scores of DS children were expected to exceed those of non-differentiated TMRs at all ages on measures of spinal flexibility. (c) Extant research led to the hypothesis that DS children would be shorter than non-differentiated TMRs at all age levels.

(d) Males were expected to be stronger than females at all age levels, and taller than females in the older age groups.

Procedure

Strength and flexibility data were obtained from the Rarick and McQuillan (1977) study of institutionalized and home reared TMR children from the San Francisco Bay Area. Down's children from the original sample of 453 TMRs were identified by means of school medical records. Stratified random sampling was employed to select samples of non-differentiated TMRs equal in size to the DS samples in each age-sex category. The 94 non-differentiated and 94 DS TMRs thus selected were grouped into age, sex, and disability categories as follows.

Table 1. Distribution of TMR Subjects by Age, Sex, and Disability

Age	Downs males	Non-diff. males	Downs females	Non-diff. females	Total
6.0-9.9 yrs.	10	10	10	10	40
10.0-14.9 yrs.	27	27	27	27	108
15.0-18.9 yrs.	10	10	10	10	40
Total	47	47	47	47	188

The test variables from the Rarick and McQuillan factor analysis study which yielded the highest loadings on the strength and flexibility factors and which were common definers across all age groups were used as indices of strength and flexiblity in the present investigation. Strength measures included Cybex recordings of maximum force of elbow flexion and elbow extension and number of revolutions obtained in bicycle ergometer tests of ten seconds duration with and without resistance. Flexibility was described by degree of movement on spinal rotation, spinal extension, lateral spinal extension, and spinal flexion (toe touch) tests. Height measures for all children were also included in data analyses. For a complete description of these tests and of testing procedures consult Rarick and McQuillan (1977).

Separate two way analyses of variance were calculated on each of the selected test measures in each of the three age categories. In each analysis the sex, disability, and sex X disability comparisons were tested at alpha .05, resulting in an experimental error rate of alpha .15 for each variance analysis solution. One tailed F tests were employed for those comparisons for which directional differences had been hypothesized.

Results and Discussion

Generally the data fail to support the original hypotheses of differences between disability groups. Down's children were not inferior to other TMRs on strength measures, and few differences emerged between these groups in flexibility. In contrast, sex differences did occur in the expected directions, with males exceeding females in height and strength in the older age groups. A complete summary of results may be noted in Table 2.

(1) The first hypothesis dictated that DS children would be inferior to non-differentiated TMRs on tests of strength; however, results indicate that these children perform similarly on strength measures. The three significant differences which occurred did

not represent a consistent pattern of differences between groups. Non-differentiated TMRs were superior to DS children on the Cybex elbow extension test in the 6-9 and 15-18 year age groups; however DS children displayed greater strength than other TMRs on the bicycle with resistance task in the 10-14 year age group. Strength differences cannot be inferred in the 10-14 year age group.

(2) Flexibility scores from the spinal rotation and toe touch tests support the original hypothesis of greater flexibility among DS children, while data from the lateral spinal extension and spinal extension tests do not support these predictions. Disability differences explained 9% to 16% of the variance (omega squared) in spinal rotation scores, and 27% to 29% in toe touch scores. Height may be a confounding element in toe touch scores. If DS children are shorter because of relatively short lower extremities, their toe touch scores would be inflated estimates of actual flexibility. If these scores are disregarded, only spinal rotation data suggest greater flexibility in DS children than other TMRs. Therefore a conclusion that DS children are more flexible than non-differentiated TMRs is unwarranted.

(3) The hypothesis that DS children would be shorter than non-differentiated TMRs at all age levels was fully supported by these data. Disability differences accounted for 6% to 29% of variance in height.

(4) The hypotheses regarding sex differences were supported by these data. Boys were stronger than girls in eight of ten strength tests, and boys aged 10 and older were taller than girls aged 10 and older. A general lack of interaction effects indicates that these sex differences are characteristic of both the DS and non-differentiated TMR groups. Sex and interaction comparisons could not be made in the older age groups in the bicycle test with resistance because boys pedalled against a higher resistance than girls.

Unpredicted results included a statistically significant sex difference in spinal flexion in favor of females in the 10-14 year age group and two sex X disability interactions in the 6-9 year age group. In both cases the interactions were marked by larger sex differences in the performances of non-differentiated TMRs than DS TMRs.

The results of the present study fail to confirm earlier clinical reports of hypotonicity or lack of muscular strength among DS children. Two possible explanations of these findings may be found in the work of earlier investigators. As Cowie's (1970) results suggested, the symptom of deficient muscle tone may diminish with age in DS children. It is possible that the muscle tone of the DS children in the present sample has improved during early childhood to the extent that they cannot be distinguished from their TMR peers on the basis of strength tests. Inspection of mean scores in each age group indicates that DS children tend to improve in strength and decrease somewhat in flexibility with age, suggesting improved muscle tone.

Another possibility is that both DS TMRs and non-differentiated TMRs may lack strength in comparison to more intellectually normal children. Data are available for educable mentally retarded (EMR) and normal children on strength and flexibility measures identical to those used in this study (Rarick and Dobbins, 1972). Comparisons of mean performances of EMRs and TMRs in the 6-14 year age range reveal substantial strength differences

Table 2. Summary of Variance Analyses:
Sex and Disability Differences in TMR Children
on Measures of Strength and Flexibility

Test	Age	Means: Downs Boys	Non-diff. Boys	Downs Girls	Non-diff. Girls	F-ratios: Sex	Disability	S X D
Cybex Elbow Flexion (ft. lbs.)	6-9	5.06	6.19	4.59	6.15	.08a	2.15a	.05
	10-14	10.34	12.00	9.84	8.83	3.62a*	.11a	1.93
	15-18	14.77	16.95	10.80	11.76	5.98a*	.70a	.11
Cybex Elbow Extension (ft. lbs.)	6-9	6.99	10.75	7.06	6.74	4.36a*	3.33a*	4.67*
	10-14	13.20	15.62	11.60	12.47	3.90a*	1.86a	.41
	15-18	19.50	25.21	13.92	19.33	3.09a*	2.90a*	.00
Bike Without Resistance (revolutions)	6-9	13.39	15.59	12.35	10.73	4.26a*	.04a	1.79
	10-14	13.55	15.02	12.72	12.77	3.59a*	.86a	.77
	15-18	14.29	11.86	11.69	15.25	.07a	.02a	2.69
Bike With Resistance (revolutions)	6-9	11.51	10.77	8.51	4.86	9.34a*	2.26a	1.00
	10-14	9.38	8.26	10.86	8.88	b	3.61a*	b
	15-18	10.06	10.50	9.28	13.81	b	2.76a	b
Spinal Rotation (degrees)	6-9	215.59	216.21	228.46	192.81	.38	4.25a*	4.56*
	10-14	218.67	195.99	223.61	178.90	.67	20.51a*	2.19
	15-18	213.14	175.94	197.13	180.67	.20	4.66a*	.70
Spinal Extension (degrees)	6-9	54.91	57.15	54.90	53.93	.22	.03a	.22
	10-14	51.60	51.52	51.70	53.01	.22	.13a	.17
	15-18	50.84	47.53	57.47	49.41	2.90	5.18a*	.90
Lateral Spinal Extension (degrees)	6-9	62.68	66.00	65.55	58.02	.39	.27a	1.76
	10-14	57.36	60.36	59.26	58.61	.00	.20a	.48
	15-18	65.00	59.32	59.94	59.57	1.03	1.62a	1.25
Spinal Flexion (Toe Touch - cm.)	6-9	30.60	25.30	32.92	21.60	.10	14.36a*	1.88
	10-14	27.19	15.62	30.59	20.51	5.95*	40.56a*	.19
	15-18	25.43	13.23	29.61	19.17	3.18	15.93a*	.10
Height (cm.)	6-9	115.27	119.51	113.87	124.03	.21	4.46a*	.75
	10-14	144.07	148.59	137.95	144.32	6.01a*	6.61a*	.19
	15-18	153.54	172.52	141.99	151.89	38.56a*	31.06a*	3.07

* $\bar{F}$(critical value 1,39; alpha = .05) = 4.09 (6-9 and 15-18 year age groups)
* $\bar{F}$(critical value 1,104; alpha = .05) = 3.94 (10-14 year age group)

a. F test performed as a one-tailed test.
$\bar{F}$(critical value 1,39; alpha = .05) = 2.84 (6-9 and 15-18 year age groups)
$\bar{F}$(critical value 1,104; alpha = .05) = 2.76 (10-14 year age group)

b. Sex and interaction comparisons could not be made the 10-14 and 15-18 year age groups as girls pedalled against 1½ kiloponds, and boys against 2½ kiloponds. In the 6-9 year age group all children pedalled against 1½ kiloponds resistance.

in favor of EMRs, and flexibility differences in favor of TMRs. TMRs also tend to be weaker and more flexible than intellectually normal children.

The findings regarding hyperflexibility are not clear with respect to earlier reports in the literature. Both DS and non-differentiated TMRs tend to be more flexible than EMRs or intellectually normal children: hyperflexibility of both groups may be partly related to poor muscle tone. However, etiological differences between the TMR groups may account for the greater flexibility of the DS children on the spinal rotation and spinal flexion measures.

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Living Environments and the Motor Performance of Mentally Retarded Children

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Researchers have long been interested in the effects that environmental circumstances have on the development of humans. While investigators in the main have studied this problem with respect to socio-economic levels or by making cross cultural comparisons, a lesser number have been concerned with observing differences in young children and adolescents who have been reared in different living environments. What is being inferred is that certain physical and psychological conditions must be met if the young individual is to achieve maximum development. In other words, if the conditions of one's environment are deficient in certain characteristics, human development will be adversely affected. Some of the criteria thought to be detrimental to optimum human development have been related to poor stimulus variety, inadequate personal attachments and limitations on the scope for play and developing positive peer relationships.

The general model has been to make comparisons between individuals who have been reared in institutions (where considerable deprivation is known or assumed to exist) and children reared at home presumably under more nearly optimum conditions. If it is the quality of stimuli and these other factors in the environment which influence the development of children, then environments which vary with respect to such criteria should produce differential effects on specified aspects of growth and development, including motor performance.

According to Rarick (1973) and others, environmental circumstances do, in fact, have considerable effect on the development of motor skills. From evidence both documented (MacAndrew, 1964; and Wolfensberger, 1972) and the writer's own observations, it would be difficult to question that life in an institution provides less stimulation and a more limited range of experience than that found in a home setting.

In this study, besides the two extreme conditions of home and a large institution, it was decided to investigate a further environment thought to be intermediary in its potential for stimulating the physical and psychological development of individuals, namely a residential center for semi-independent living. A search of the literature revealed no studies of this nature. This investigation was designed therefore to determine if, in fact, TMR children and adolescents living in the above three types of settings differ in selected measures of physical growth, motor performance and intelligence.

It was hypothesized that for each motor performance variable, morphological measure and intelligence a) home reared subjects would score higher than residential subjects on all tests, and b) residential subjects would similarly score higher than institutional subjects.

Procedure

Data were obtained from the Rarick and McQuillan (1977) study

of institutionalized and home reared TMR children from the San Francisco Bay area. The TMR subjects were grouped according to their residential setting and matched for chronological age. The measures employed were those obtained in the Rarick and McQuillan (1977) study, namely those which yielded the highest loadings on

Table 1
Distribution of TMR Subjects by Age and Residential Setting

Age	Home	Residential	Institutional	Total
161-167 mos.	9	6	8	23
209-230 mos.	10	9	11	30
Total	19	15	19	53

the defined factors of arm strength, flexibility, fine visual-motor coordination, balance, leg power and upper limb-eye coordination. Also included in the study were two morphological measures and intelligence. The test items which defined each factor respectively were: the cybex recordings of maximum force of elbow flexion, the degree of movement on lateral spinal extension, the modified Minnesota Rate of Manipulation (preferred hand), the rail-walking (sideways), the number of revolutions obtained in a bicycle ergometer test with resistance, and the average score on a thirty throw target test. The morphological measures consisted of the summation of three skinfold measurements (triceps, subscapular, and abdominal) and body weight. Intelligence test scores were also included in the analysis (descriptions can be obtained from Rarick and McQuillan, 1977).

For each age category a three-way comparison was made using non-parametric methods. A Kruskal-Wallis one-way analysis of variance was used with an alpha of .05. Where a significant H was obtained pairwise contrasts were made.

Results and Discussion

The results of the several analyses are reported in Table 2. The medians of the respective groups are presented in Figure 1. As was expected there were no significant differences in chronological age among three residential groups within either of the age categories.

Of the six three-way analyses involving the motor performance variables, in the young group no statistically significant differences were found. In contrast, the findings on the old group revealed significant differences in four of the six motor performance measures, namely, those variables which represented the factors of arm strength, flexibility, balance, and upper limb-eye coordination.

In the pairwise contrasts home reared subjects performed significantly better than the institutionalized subjects on the above four measures of motor performance. Residential subjects achieved higher scores than institutionalized subjects on measures of flexibility and balance but not in arm strength and upper limb-eye coordination. Only in one case (arm strength) were the home reared individuals significantly higher than their residential peers.

The findings on the morphological measures are mixed as can be observed in Figure 1. The young home reared subjects are lighter than their old counterparts, but surprisingly, they have greater fat deposits. The young residential subjects are heavier than their

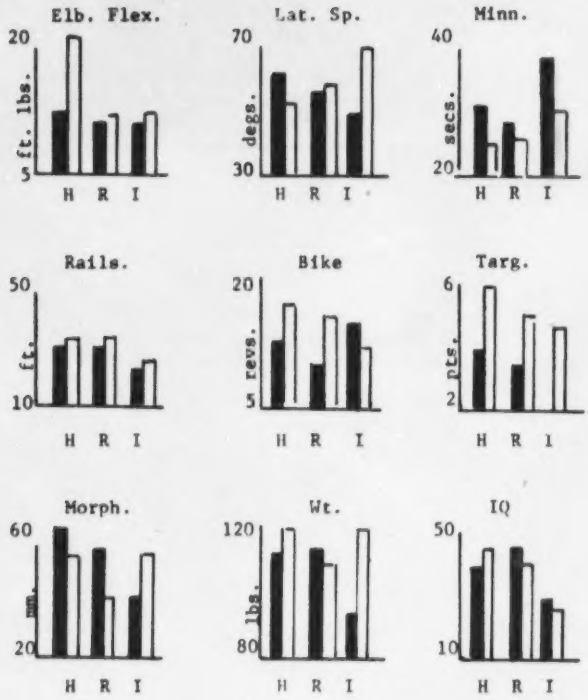

Figure 1. Median Scores of Motor Performance, Morphological and Intellectual Measures of TMR Subjects by Age and Residential Setting

old counterparts with relatively equivalent fat deposits.

In measured intelligence pairwise contrasts resulted in significant differences between the home reared and institutionalized and between the residential and institutionalized in both age categories, but no differences between the home reared and residential.

In summary, the findings show that the motor performance of the young subjects did not differ according to environmental setting, in spite of the supposedly discrepant methods of child rearing and the inferior level of intelligence of the institutionalized subjects. In contrast, the superior level of motor performance of the old subjects suggests that institutionalization for lengthy periods of time is disadvantageous to motoric aspects of development.

The most interesting of the findings was the manner in which the residential youngsters compared to those who were home reared. On seventeen of the eighteen comparisons no significant differences

Table 2. Results of Non-Parametric Analysis of the Performance of TMR Subjects on Motor Performance, Morphological and IQ Measures

Test Variable	Age	H value	Significance
Chronological Age			
3-way comparisons	161-167 mos.	.20	NS
3-way comparisons	209-230 mos.	.56	NS
Cybex Elbow Flexion			
3-way comparisons	161-167 mos.	5.68	NS
3-way comparisons	209-230 mos.	7.63	S
Pairwise contrasts			
H x I		5.37	S
H x R		5.55	S
R x I		.49	NS
Lateral Spinal Extension			
3-way comparisons	161-167 mos.	3.16	NS
3-way comparisons	209-230 mos.	12.60	S
Pairwise contrasts			
H x I		10.04	S
H x R		3.32	NS
R x I		5.15	S
Minnesota Manipulative			
3-way comparisons	161-167 mos.	1.93	NS
3-way comparisons	209-230 mos.	4.85	NS
Railwalk Sideways			
3-way comparisons	161-167 mos.	.27	NS
3-way comparisons	209-230 mos.	12.18	S
Pairwise contrasts			
H x I		7.93	S
H x R		1.67	NS
R x I		9.70	S
Bicycle With Resistance			
3-way comparisons	161-167 mos.	5.20	NS
3-way comparisons	209-230 mos.	1.85	NS
Target Throw			
3-way comparisons	161-167 mos.	.10	NS
3-way comparisons	209-230 mos.	8.42	S
Pairwise contrasts			
H x I		8.29	S
H x R		3.01	NS
R x I		1.14	NS
Weight			
3-way comparisons	161-167 mos.	7.00	S
Pairwise contrasts			
H x I		6.02	S
H x R		.01	NS
R x I		4.00	S
3-way comparisons	209-230 mos.	2.10	NS
Morphological Measures			
3-way comparisons	161-167 mos.	9.90	S
Pairwise contrasts			
H x I		4.68	S
H x R		.68	NS
R x I		3.26	NS
3-way comparisons	209-230 mos.	.37	NS
IQ			
3-way comparisons	161-167 mos.	14.30	S
Pairwise contrasts			
H x I		11.66	S
H x R		.13	NS
R x I		9.60	S
3-way comparisons	209-230 mos.	8.80	S
Pairwise contrasts			
H x I		7.48	S
H x R		.88	NS
R x I		5.12	S

3-way comparisons H(critical value 2 df; alpha = .05) = 5.99
Pairwise contrasts H(critical value 1 df; alpha = .05) = 3.84

at either age level were recorded. This may be an indication that the semi-independent living environment provided care and facilities for its residents which were perhaps of equal caliber to those available to home reared individuals.

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Motor Performance and Physical Growth Components of Headstart and non-Headstart Preschool Children

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Numerous investigations have provided rather comprehensive information on the factor structure of motor abilities and physical growth components in man. While most of the factor analytic research has been conducted with adolescent college-age subjects or mental retardates, few have involved preschool children. Early factor analytic research (3) identified such factors as agility, grip strength and hand-eye coordination. Running speed and static balance, coordination, flexibility, physical fitness, power, endurance and dynamic shoulder strength factors were isolated in other test batteries (1,4,5,13,17). Factor analytic research by Barry and Cureton (1) with boys, ages 7 to 11 years old identified three motor performance and five physique factors. Rarick and Dobbins (14) in their investigation isolated five motor performance and one physique factor in a sample of 71 boys and 74 girls, ages six to 9.9 years. The factor analytic research by Whitener and James (18) of the motor abilities of children three to four years old on the Whitener Motor Performance Battery of Tests revealed the existence of five factors, namely Total Body Strength, Leg Power, Arm and Shoulder Strength, Gross Coordination, and Rhythmic Coordination. A sample of five year olds in the above study revealed the following components: Speed of Movement, Power, Gross Motor Coordination, Dynamic Balance, and Arm and Total Body Strength. A study by Seefeldt, Peterson and Reuschlein (16) on the factor structure of motor performance and physical growth of kindergarten, first and second grade children, isolated such factors as body size, body structure, balance, coordination, and grip strength. A review of the literature disclosed that none of the factor analytic investigations published to date has included within its scope a range of participants from various socio-cultural backgrounds broad enough to encompass a major part of the motor domain of preschool children.

The study was designed to determine the factor structure of motor performance and physical growth components of four and five year old children enrolled in Project Headstart and non-Project Headstart preschool programs and to compare the components of the factor structure of these four groups.

Procedures

Participants. From San Francisco and the East Bay area, 50 boys and girls aged 4 years and 50 boys and girls aged 5 years were randomly selected from Headstart programs. The number selected from non-Headstart programs for testing was 50 children aged 4 years and 50 children aged 5 years from the same geographical area. In the sampling procedure boys and girls were randomly assigned to their respective age and program groups, under the assumption that sex differences at ages 4 and 5 would not influence the outcome of the factor structure analysis.

Test Administration. A total of 29 measures of muscular strength,

gross and fine motor coordination, and physical growth were administered to the children over a period of five months. A detailed description of the tests has been reported elsewhere (2).

Method of Data Analysis. Intercorrelations were run among the 29 tests and factor analytic methods following the strategy proposed by Harris and Harris (6). The computing algorithms for the initial solutions included the Incomplete Principal Components (8), Rao's Canonical Factor Analysis (15), and Alpha Factor Analysis (10). These three factor analytic procedures provide two components solutions, Incomplete Principal Components and Rao's Canonical, each having a statistical basis, and one factor solution with a psychometric basis, namely Alpha Factor Analysis. Each of the three initial solutions was rotated orthogonally by the Varimax procedure (11) and obliquely by the Harris-Kaiser method (7) resulting in six derived solutions. The criterion for determination of the number of factors was the Kaiser-Guttman rule (7), which recommends the orthogonal rotation of only those factors of the original matrix with eigenvalues greater than 1. In all initial oblique solutions the default value was set at zero. The procedures used to identify the factors that were common across solutions in respect to the communality of variables that loaded on a given factor followed closely that outlined by Harris and Harris (6). A comparable common factor was defined as one having two or more of the same relevant variables with rotated loadings greater than .30 on at least five of the six derived solutions.

The final step of the data analysis involved the application of a procedure for assessing quantified relationships among factor structures of several groups of children when the same variables have been factored in each instance (12). The procedure used the orthogonally rotated Principal Component solutions initially extracted from two correlation matrices and these transformation matrices for rotating to the reference vectors. The method yields a measure of relationship between all factors of two subject groups simultaneously and may be interpreted as a correlation coefficient.

Results and Conclusions

Ten factors with eigenvalues in excess of 1.00 were extracted from the intercorrelation matrices of 29 motor performance and physical growth measures by the Incomplete Principal Component, the Alpha and the Rao solutions. The results of the factor analyses disclosed a well defined factor structure of motor abilities and anthropometric measurements in both the Headstart and the non-Headstart children at both age levels. Six comparable common factors were isolated in all four groups.

The following summarized the major findings of the investigation:

(1) The factor analysis disclosed a well defined factor structure of motor performance and physical growth in the Headstart preschool children. The factor structure of the non-Headstart children was also well defined and highly similar.

(2) A Body Fat or Dead Weight factor with consistently high loadings of the skinfold measures emerged in all four groups of children.

(3) A second comparable common factor, namely Body Size, was extracted from all four groups. The loadings on measures of sitting height, standing height, weight and body breadth were substantial.

(4) A factor best described as Power and Gross Motor Coordina-

tion emerged in all four groups. Such measures as throwing, performing the vertical jump and long jump had moderately high loadings on this third comparable common factor. The ability to execute these skills clearly calls on muscular power and coordination.

(5) A fourth comparable common factor appeared to be a factor of Upper Extremity and Shoulder Girdle Strength as evidenced by the loadings on tests of grip strength, pull and thrust and the strength to support the body in a free hanging position.

(6) Comparable common factor five with moderately high loadings on the measures of fine motor control was clearly a factor of Fine Motor Coordination, represented with high loadings on variables such as golfball placement, Minnesota Manipulative, and ring stack test in all four groups of children.

(7) In view of the high loadings on the railwalk tests and running variables comparable common factor six was defined as a factor of Balance and Coordination.

(8) The quantified relationships among factor structures may be noted as follows:

a. four out of six cosines were above .70 for the factor Body Size and Body Fat;
b. the cosine values for the Power and Gross Motor Coordination factor were moderate, with three above .50 and three between .47 and .50;
c. the cosine values for the Upper Extremities and Shoulder Girdle Strength factor were .65 and higher;
d. the cosine values of comparable common factor 5, Fine Motor Coordination, range from a low of .42 to a high of .70;
e. the cosine values of the factor axes of comparable common factor 6, Balance and Coordination, were moderately low in their magnitude.

The findings suggest that a defined factor structure does exist in four and five year old Headstart and non-Headstart children and supports the earlier findings of Seefeldt (16) and James (9). The scope of the test batteries within a category of hypothesized factors should be expanded in future research. This will allow more conclusive statements regarding the comprehensive nature of the factor structure of the motor performance and physical growth of children at these ages.

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The Effects of 2 Remedial Movement Programs on Selected Performance Criteria Using 1st Graders with Learning and Motor Problems

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There is an ample body of literature supporting the contention that movement experiences play a vital role in the growth and development of the young child (1, 6, 9). Research studies have been launched to investigate the validity of the premise that a carefully devised sensory or perceptual-motor program will enhance function not only in the motor domain but will facilitate academic achievement as well. Such efforts have thus far produced contradictory findings. Hence, the findings are inconclusive.

There are those studies which report significant gains on perceptual-motor measures but fail to reveal concomitant gains on cognitive items (7, 10). While some data indicate improvement on a wise range of measures (8), still others reveal no significant changes on any of the selected variables (4). Further, the singular nature of individual studies render comparisons somewhat tenuous. Typically distinguishing features include variations in hypotheses, sampling procedures, sample selection and size, variables tested, instruments chosen and methods employed.

Of real concern is that in response to recently enacted federal legislation (PL 94-142 and section 504) which mandates prescriptive and nondiscriminatory education and explicity calls for appropriate psychomotor programs, there has been a dramatic upsurge in the use of movement within the public schools as a remedial tool to upgrade and advance academic learning. The dilemma in terms of educational ramifications has been the tendency for schools to indiscriminately adopt programs with scant evidence of their remedial efficacy.

Thus, the apparent need for careful scrutiny of programs under controlled conditions generated the impetus for the present project. The purpose was two-fold: 1) to compare the effects of two special movement treatment interventions, Dance/Movement Therapy (DMT) and Sensory Motor Activities (SMA), with a program a traditional physical education on selected performance parameters (academic, visuo-perceptual-motor and behavior) using first grade children identified as having learning and perceptual-motor problems; and 2) to determine whether those children exposed to DMT would differ significantly from those in the SMA group as a function of the respective treatments with respect to the dependent variables.

Procedures

A sample of 68 subjects (31 girls and 37 boys) were recruited from first grade classes of two neighboring elementary schools in the San Francisco Bay area located in communities characterized as lower socioeconomic and transient. Eligibility for sample inclusion was centered on test scores which fell below the 25th percentile on the Comprehensive Test of Basic Skills (CTBS) and on reports of perceptual-motor difficulties based on motoric screening and/or teacher recommendations.

Pupils from school I (Exp.) were randomly divided and assigned to either Treat. I (DMT) or Treat. II (SMA) and then subdivided into groups of 7 or 8 for the treatment sessions. The resultant group membership was: DMT - 12 boys, 9 girls; SMA - 12 boys, 11 girls. The controls, located in School II, numbered 13 boys, 11 girls. Mean ages were 6 years 6 months for the Exp. groups; 6 years 8 months for the controls.

Test Instruments

Complete pre and posttest data were collected on all the criterion measures, namely: CTBS, (Academic), Frostig Developmental Test of Visual Perceptual (DTVP) (Visual-motor), Frostig Movement Skills Battery (MSB) (Perceptual-motor), Children's Checking Test (CCT) (Attention span), and Conners Teacher Rating Scale (CTRS) (behavioral correlates of Hyperactivity). A total of 18 variables were derived from the above five tests, namely: (1) CTBS - Reading, Language, Mathematics; (2) DTVP - Eye-Hand, Figure-Ground, From Constancy, Position in Space, Spatial Relations; (3) MSB - Hand-Eye, Strength, Balance, Flexibility, Visually Guided Movement: (4) CCT; and (5) CTRS.

Treatment

Two distinctive movement models were examined. The first, DMT, merged the theoretical constructs of Ayres (1) and Kephart (6) which stress normalization of sensory and perceptual-motor processes with an approach that is oriented toward movement experiences derived from problem solving via motor exploration (3, 9). The techniques included cross modal stimulation of the various sensory systems. Emphasis here is placed on development of basic movement patterns, i.e. locomotor and non-locomotor (walk, run, jump, hop, swing, twist, turn, stretch, bend, etc.) within the context of Time (tempo and rhythm), Space (direction, pathway, level, shape), and Force (light, strong).

The second movement treatment was an adaptation of Ayres Sensory Integration, a therapy primarily designed to normalize automatic neurologic responses at brain stem level of the CNS. The program which adheres closely to standard Ayres protocols (for details of Ayres clinical procedures see reference 1) was supervised by an occupational therapist. Typically, apparatus such as platform and hammock swings, barrels, inflatables and scooter boards were employed to provide vestibular stimulation; textured surfaces, vibrators, geometric shapes were furnished to offer tactile input.

The controls continued to participate in their routine physical education activities.

Training for the Exp. groups extended over a 13 week period during which time they received 30 minutes of special movement activity three times a week.

Results

To determine the differential effects of treatment among the groups, three Multivariate Analyses of Covariance (MANCOVA) and one Univariate Analysis of Covariance (UANCOVA), based on 18 dependent variables and grouped according to treatment and sex were run. Each MANCOVA clustered a different combination of variables; scores of the 15 subtests containing academic, visuo-perceptual-motor and behavioral variables: scores of the five total tests; and scores of the five subtests of the MSB. Only the

UANCOVA which used the total scores ofthe MSB yielded statistically significant differences for the treatment effect. A follow-up preplanned orthogonal test of comparisons on the total MSB between the combined means of the Exp. groups and that of the controls disclosed differences beyond the .05 level. A second test of contrasts, this time between the two Experimental groups on the total MSB did not yield statistically significant differences. For the main effect of sex, significant differences were recorded on the 15 variable MANCOVA and UANCOVA favoring the girls.

Secondary analyses were also conducted to provide descriptive data. Pearson Correlation Coefficients were computed between pre and posttest scores of each test variable to examine the stability of individual test performance. Table 2 lists the obtained coefficients. Generally, low and fluctuating pre-posttest r's underscored erratic and unpredictable test performance over time among the groups on particular test variables as well as within the groups from test to test. Variability was punctuated by r's in the low ranges of -.27 (Math) and -.10 (spatial relations) to higher r's of .74 (lang) and .84 (CTRS - a teacher rated measure). Isolated items which demonstrated uniform through moderate reliability across the groups (r = .43 - .74) were Language, Balance, Flexibility and the CCT.

Lastly, in order to clarify the possible effects of the two movement treatments on performance as measured by the 15 subtests, pre and posttest scores were separately factor analyzed for each group using the Principle Component Solutions. Loadings on Factor I disclosed shared commonalities in Reading and the CCT, suggesting an academic and attention span factor. Other factors were less clearly defined: Factor II - loadings tended to cluster on visuo-perceptual-motor items; Factor III - predictable and strong loadings were confined to the DMT group, specifically on perceptual-motor variables; Factor IV - a desultory pattern of loadings characterized this factor although common variance was displayed for language; Factor V - loadings were unsystematically scattered among perceptual-motor items within and across groups; Factor VI - essentially isolated loadings on flexibility for the DMT and SMA groups suggested an independent factor. In toto, emergent factors reflected unstable pre-posttest factor structures within each group in addition to variability in performance patterns among the groups.

Discussion

Based on the findings, significant treatment differences among the groups were not detected on either the academic and visuo-perceptual-motor subtests or behavioral measures. A significant P-value was reached only on the total MSB. However, in light of the unpredictibility of group performance over time coupled with the overall variability of factor structures exhibited within and among groups, the absence of a treatment effect might be more a reflection of idiosyncratic performance and/or unstable test instruments than an indicator of treatment efficacy. More precisely, consistently low and variable pre-posttest r renders suspect the reliability of criterion measures despite reported evidence of moderate to high validity and reliability. These tests may, nonetheless prove inappropriate for children with learning problems and/or those who are economically deprived (5). Moreover, economically disadvantaged youngsters with learning problems may

TABLE I

Summary of three 3x2 MANCOVA and one ANCOVA Using Pre and Posttest Scores of Dependent Variables

Effects	F-ratio	P-value*
MANCOVA: 15 subtests		
Treatment	.84	.69
Sex	2.00	.05**
Treatment by Sex	.79	.76
MANCOVA: 5 subtest		
Treatment	1.26	.26
Sex	1.60	.18
Treatment by Sex	.55	.85
MANCOVA: 5 subtests MSB		
Treatment	1.50	.15
Sex	2.03	.09
Treatment by Sex	.43	.79
ANCOVA: total MSB		
Treatment	3.95	.02**
Sex	4.57	.04**
Treatment by Sex	.50	.61

*Significant for rejection of the null hypothesis set at .05 level
**$p < .05$

TABLE II

Correlations between Pre and Posttest Scores for the 15 Subtests for Each Group

Subtests	Treat I (N = 21)	Treat II (N = 23)	Control (N = 24)
CTBS			
Reading	.35	-.07	.35
Language	.74**	.68**	.48*
Mathematics	.26	.13	-.27
DTVP			
Eye-Hand Coord.	.45*	.62**	.05
Figure-Ground	.27	.28	.37
Form Constancy	.71**	.65**	.23
Post. in space	.39	.38	.21
Spatl. Relations	-.10	.58**	.36
MSB			
Hand-Eye	.35	.65**	.74
Strength	.49*	.33	.43*
Balance	.57**	.56**	.43*
Vis. Guided Mvt.	.42	.03	-.03
Flexibility	.47*	.48*	.66**
CCT	.73**	.55*	.54**
CTRS	.75**	.84**	.83**

*$p < .05$
**$p < .01$

typically manifest more singular and erratic performance patterns than their nondisadvantaged, normally achieving peers (2). Likewise, even tests intended for special populations may display unreliability when standardized on normal subjects.

Ergo, before movement treatments can be validly assessed, stable and appropriate measures need be available to the researcher. Additionally, if idiosyncratic behavior is characteristic of exceptional populations, then the nature and extent of their variance must be assessed prior to designing test instruments which can validly and reliably tap and quantify specific parameters of performance.

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